Digital Image Processing Homework 4

Bodong Zhang u0949206

4(a)

According to Wiener Filter, if the Fourier Transform of original image is I, H is the degradation in Fourier domain, K is Sn/Sf, Io is the output image.

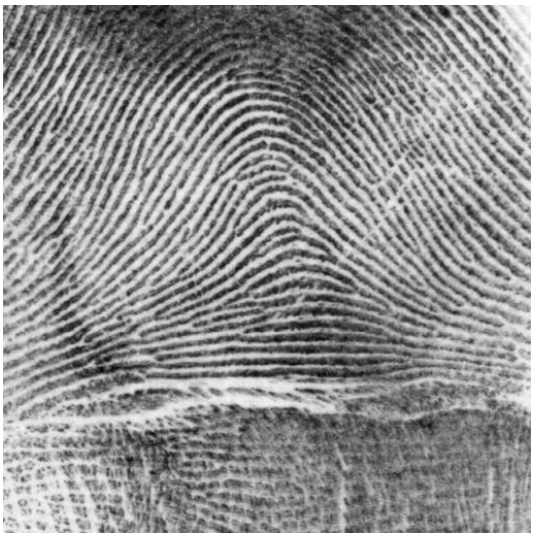
Then the best filter W to minimize $E(|f-\tilde{f}|^2)$ is $W(u,v)=\frac{H(u,v)^*}{H(u,v)H(u,v)^*+\frac{S_n}{S_f}}$

G=HF+N, $\tilde{F}$=WG. N is noise, $\tilde{F}$ is estimated original image in frequency domain.

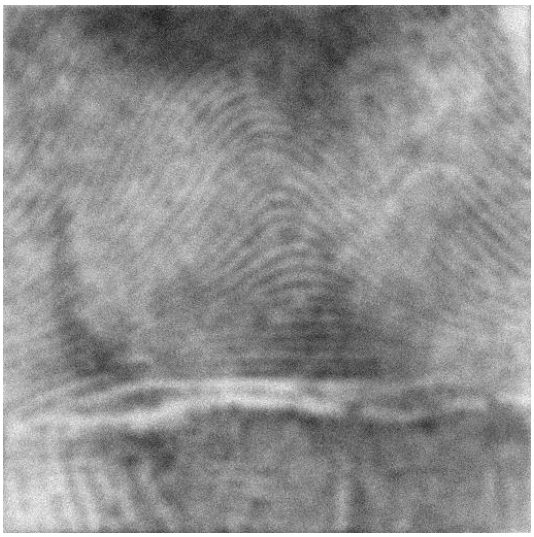
```
function Io= WienerReject(I,H,K)
%where I is the degraded input image(spatial domain), H is the degradation
in the Fourier domain(shifted), K is the
% % %parameter for Wiener filtering and Io is the output image(spatial
domain). _
    if(ndims(I)==3)
        I=rgb2gray(I);
    end
    %intensity should between 0 and 1
    if max(max(I))>1
        display('Intensity should not exceed 1');
        pause;
    end

    if min(min(I))<0
        display('Intensity should not be smaller than 0');
        pause;
    end
    %transform image into frequency domain
    I_fre=fft2(I);
    I_fre_shift=fftshift(I_fre);

    [m,n]=size(I_fre_shift);
    if size(I_fre_shift)~=size(H)
        display('size(I_fre_shift)~=size(H)');
        pause;
    end
    I_fre_shift_filtered=zeros(size(I_fre_shift));
    %Wiener Filtering
    for u=1:m
        for v=1:n

I_fre_shift_filtered(u,v)=I_fre_shift(u,v)*conj(H(u,v))/(abs(H(u,v))*
```

```
abs(H(u,v))+K);
        end
    end
    %Transform into spatial domain
    I_fre_filtered=ifftshift(I_fre_shift_filtered);
    Io=ifft2(I_fre_filtered);


end
```

(b) The original image and degraded image by Blur Degradation is



Original Image



Degraded Image

The MSE of Degraded Image is 1516.9

Rewrite Degradation function as

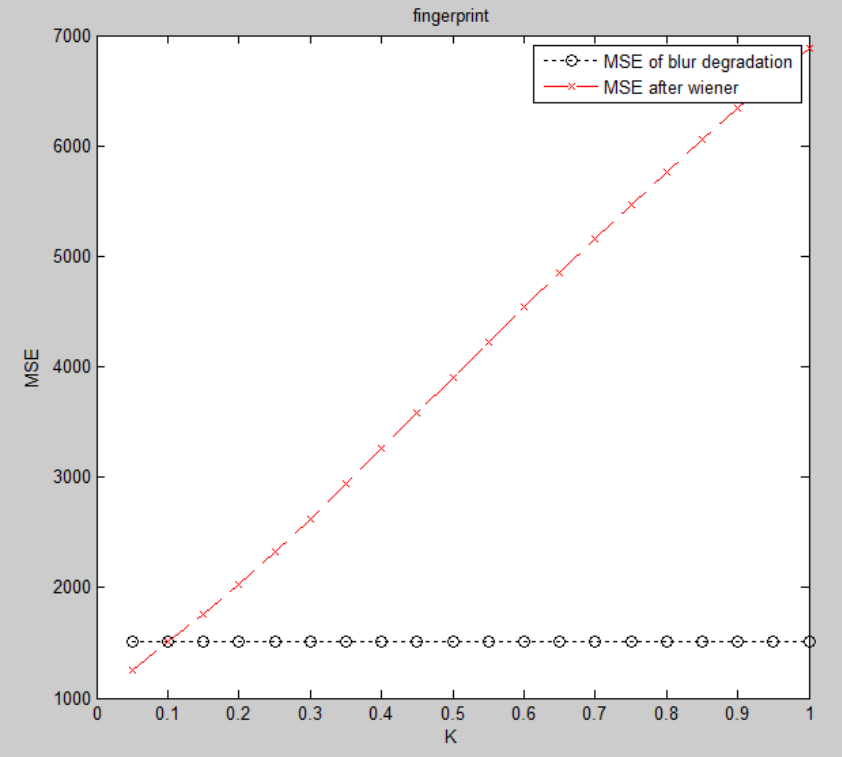
```
function [gblur, H_blurdegradation] = BlurDegradation(f)
%range 0-255
f = double(f);
M = size(f,1);
N = size(f,2);
sigma_n = max(f(:))*0.05;
sigmaspatial = 4;
Hblur=zeros(size(f));
sigmafreq = sqrt(1/(4*pi^2*(sigmaspatial/512)^2));
for u=1:size(f,1)
    for v=1:size(f,2)
        %create H
        Hblur(u,v) = exp(-((u-M/2).^2+(v-N/2).^2)/(2*sigmafreq^2));
    end;
end;
H_blurdegradation=Hblur;
Hblur = ifftshift(Hblur);
```

```
gblur = real(ifft2(Hblur.*fft2(f)))+sigma_n*randn(M,N);
end
```

We add another output to receive H.

We would use different K to apply Wiener Filtering and calculate the MSE to find the best K.

First we try K=0.1 to 1 with interval 0.05 and draw the MSE line.



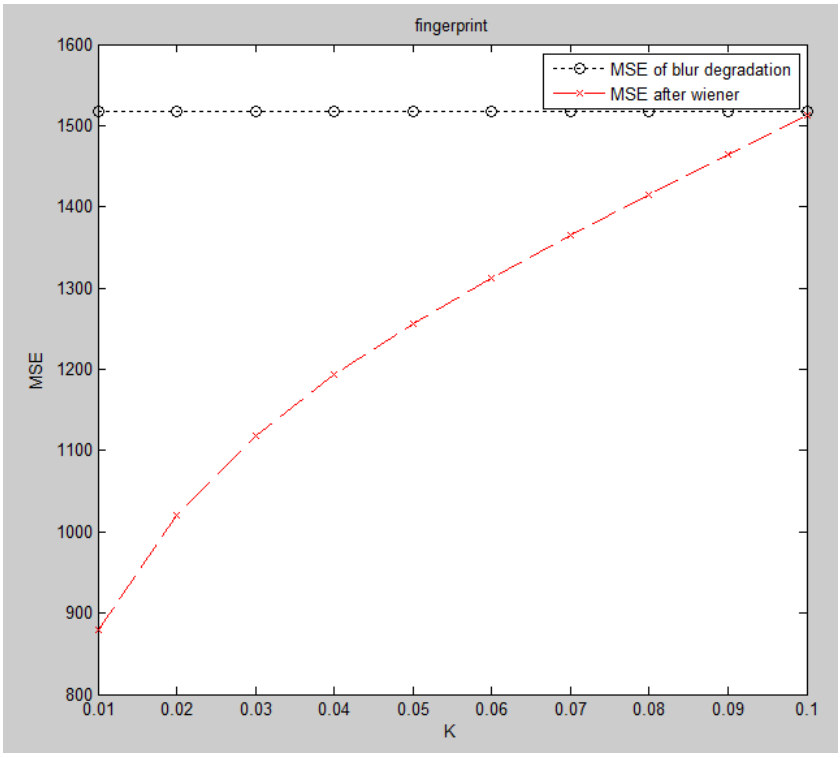
p | pT | y | tau | xbbT | all_p | fingerprint_gblur | I_01 | Io_real | H_blurdegradation | save_MSE_wiener

3x20 double

1	2	3	4	5	6	7	8	9	10	11	12
0.0500	0.1000	0.1500	0.2000	0.2500	0.3000	0.3500	0.4000	0.4500	0.5000	0.5500	0.6000
1.5169e+03	1.5169e+03	1.5169e+03	1.5169e+03	1.5169e+03	1.5169e+03	1.5169e+03	1.5169e+03	1.5169e+03	1.5169e+03	1.5169e+03	1.5169e+03
1.2538e+03	1.5113e+03	1.7620e+03	2.0316e+03	2.3199e+03	2.6229e+03	2.9360e+03	3.2554e+03	3.5779e+03	3.9008e+03	4.2222e+03	4.5406e+03

So the best K should between 0 and 0.1.

We try K=0.01 to 0. 1 with interval of 0.01 and draw the MSE line.



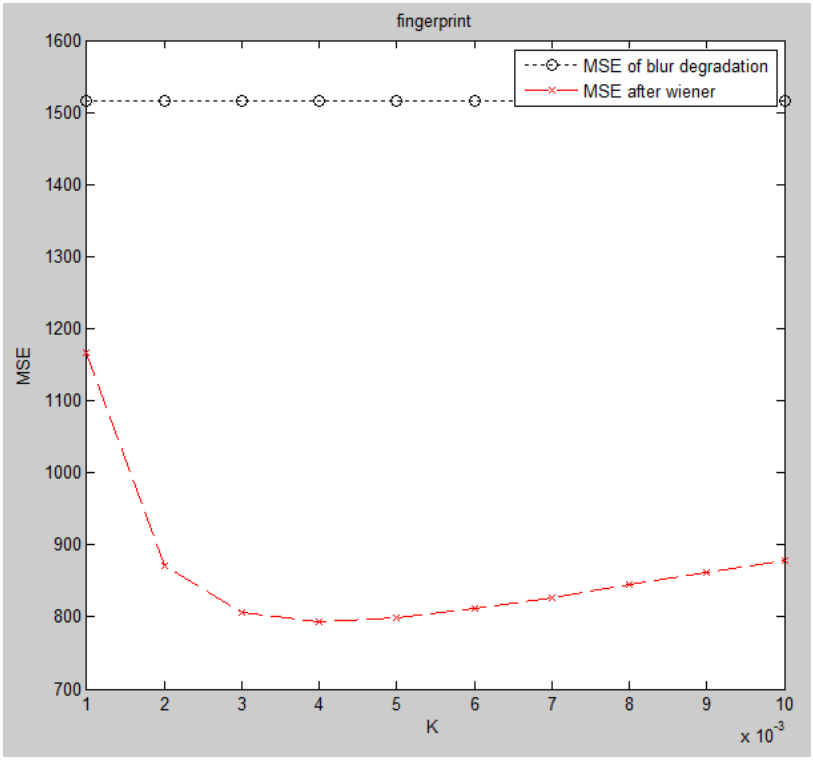
p | pT | y | tau | xbbT | all_p | fingerprint_gblur | I_01 | Io_real | H_blurdegradation | save_MSE_wiener

3x10 double

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0100	0.0200	0.0300	0.0400	0.0500	0.0600	0.0700	0.0800	0.0900	0.1000		
2	1.5181e+03	1.5181e+03	1.5181e+03	1.5181e+03	1.5181e+03	1.5181e+03	1.5181e+03	1.5181e+03	1.5181e+03	1.5181e+03		
3	880.0427	1.0211e+03	1.1184e+03	1.1933e+03	1.2561e+03	1.3122e+03	1.3645e+03	1.4148e+03	1.4640e+03	1.5129e+03		

So the best K should between 0 and 0.01.

We try K=0.001 to 0. 01 with interval of 0.001 and draw the MSE line.



ge_processing ▸ hw4 ▸ hw4_prog_Bodong

Variables - save_MSE_wiener

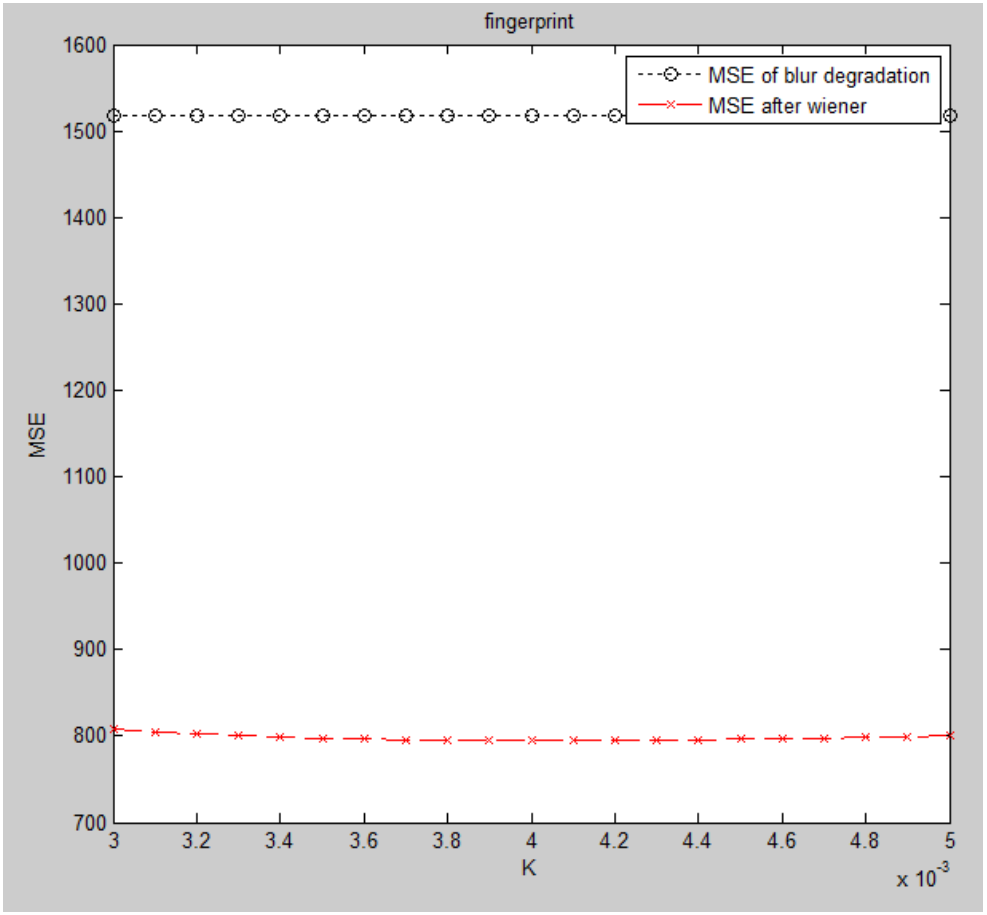
y | tau | xbbT | all_p | fingerprint_gblur | I_01 | Io_real | H_blurdegradation | save_MSE_wiener | MSE_wiener

3x10 double

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.0000e-03	0.0020	0.0030	0.0040	0.0050	0.0060	0.0070	0.0080	0.0090	0.0100		
2	1.5163e+03	1.5163e+03	1.5163e+03	1.5163e+03	1.5163e+03	1.5163e+03	1.5163e+03	1.5163e+03	1.5163e+03	1.5163e+03		
3	1.1672e+03	871.0753	805.5996	792.9870	798.5386	811.3904	827.2788	844.2980	861.5340	878.5281		
4												

So the best K should between 0.003 and 0.005.

We try K=0.003 to 0. 005 with interval of 0.0001 and draw the MSE line.

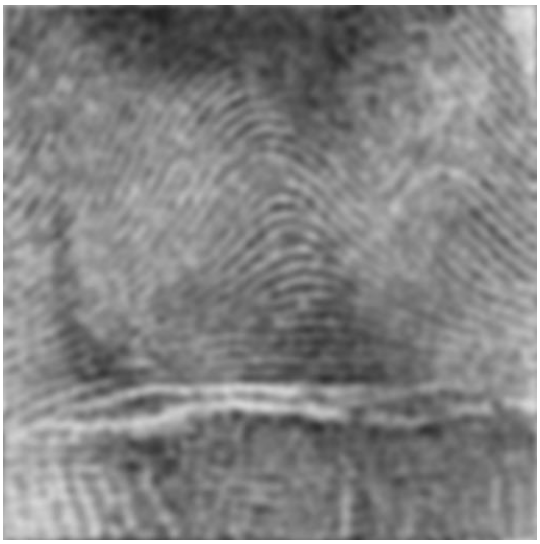


xbbT | all_p | fingerprint_gblur | I_01 | Io_real | H_blurdegradation | save_MSE_wiener

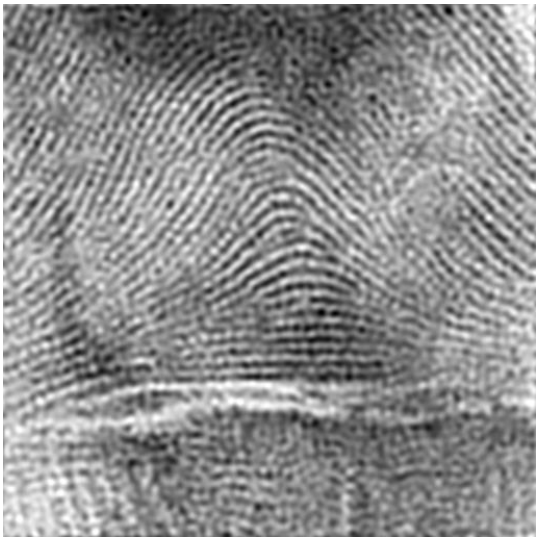
8	9	10	11	12	13	14	15	16	17
0.0037	0.0038	0.0039	0.0040	0.0041	0.0042	0.0043	0.0044	0.0045	0
172e+03	1.5172e+03	1.5172e+03	1.5172e+03	1.5172e+03	1.5172e+03	1.5172e+03	1.5172e+03	1.5172e+03	1.5172
795.8647	795.3026	794.9451	794.7734	794.7705	794.9214	795.2127	795.6321	796.1685	796

As a result, the best K is 0.0041. The MSE is 794.7705. K should not be too small or large. If K is too small, then W=1/H, if H(u,v) is too small in some area, then recovered image would be greatly influenced by noise. If K is too large, then the detail would be suppressed.

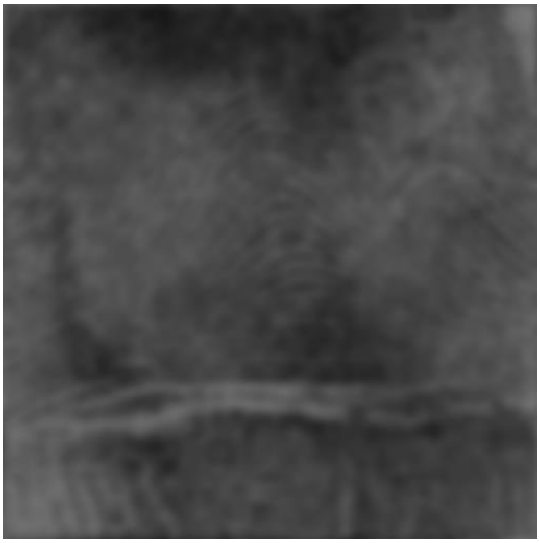
The Wiener Filtered Images with different K are shown below



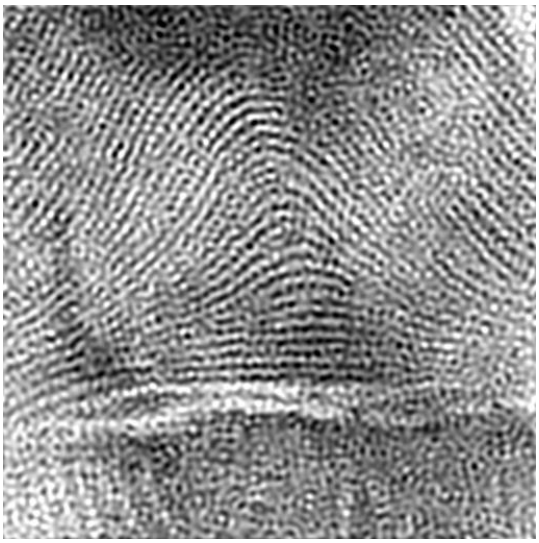
K=0.1



K=0.0041(min MSE)



K=1



K=0.001

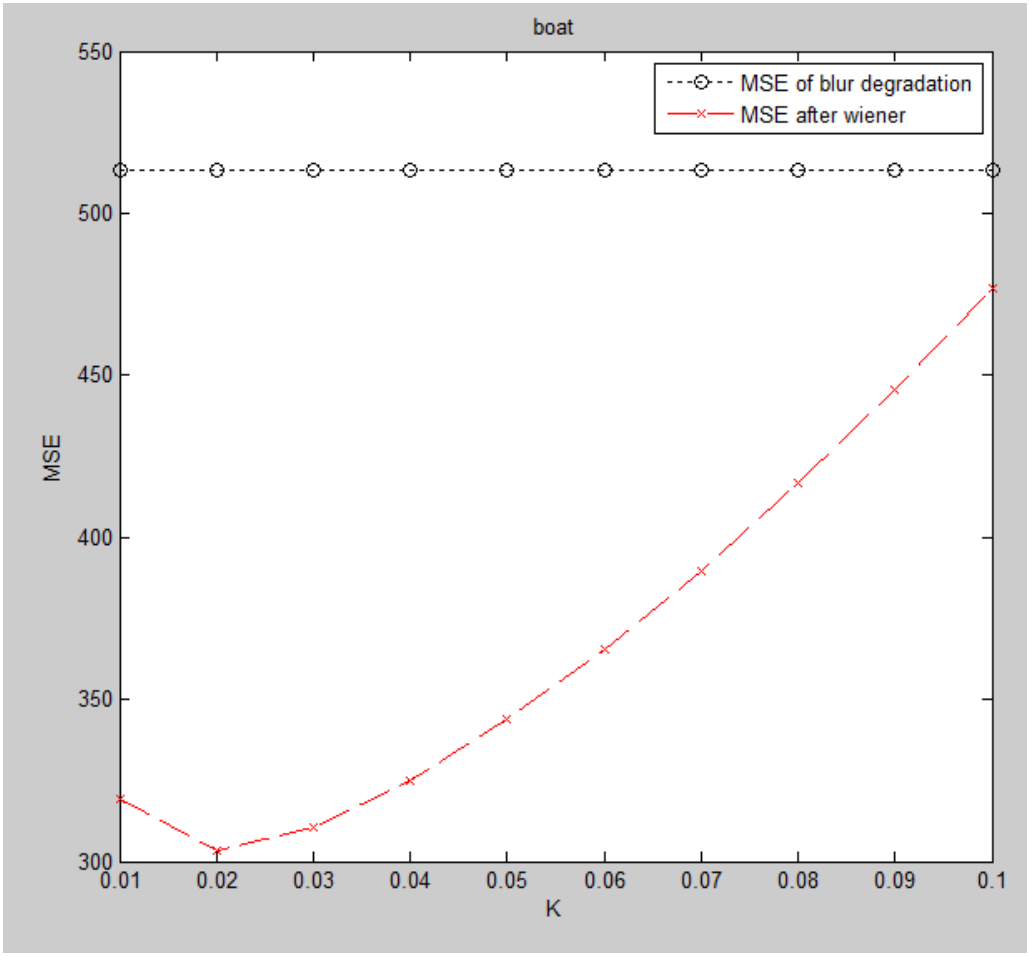
(c) We change the input image to boat image

Original Image

Degraded Image

The MSE of Degraded Image is 513.459

We would use different K to apply Wiener Filtering and calculate the MSE to find the best K.
First we try K=0.01 to 0. 1 with interval 0.01 and draw the MSE line.



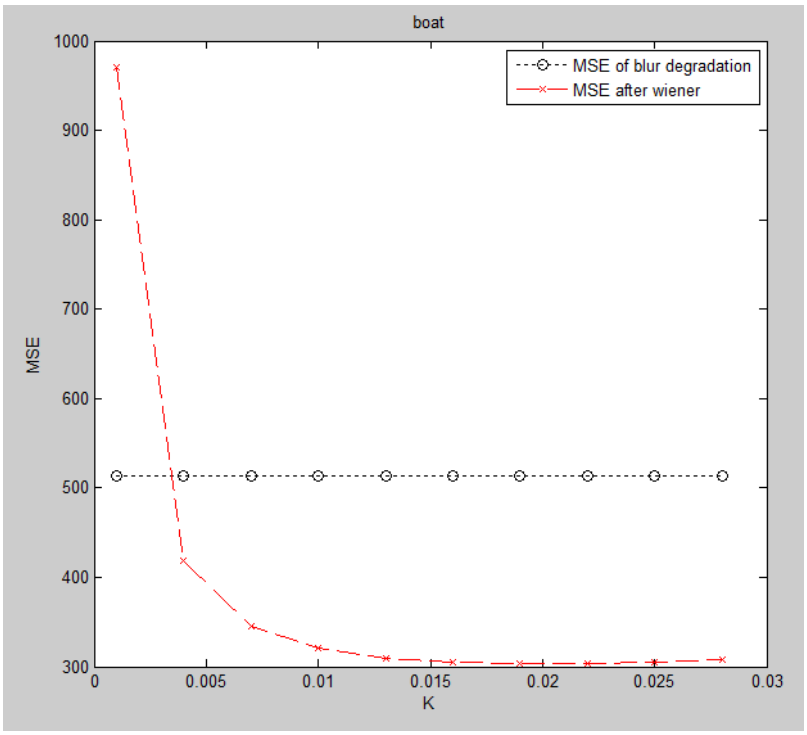
Variables - save_MSE_wiener

p | pT | y | tau | xbbT | all_p | fingerprint_gblur | I_01 | Io_real | H_blurdegradation | save_MSE_wiener | MSE

3x10 double

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.0100	0.0200	0.0300	0.0400	0.0500	0.0600	0.0700	0.0800	0.0900	0.1000			
2	513.4590	513.4590	513.4590	513.4590	513.4590	513.4590	513.4590	513.4590	513.4590	513.4590			
3	319.4421	303.1168	310.5590	325.0793	343.6789	365.3936	389.7811	416.5765	445.5887	476.6619			

So the best K should between 0 and 0.03
We try K=0.001 to 0. 03 with interval of 0.003 and draw the MSE line.



Variables - save_MSE_wiener

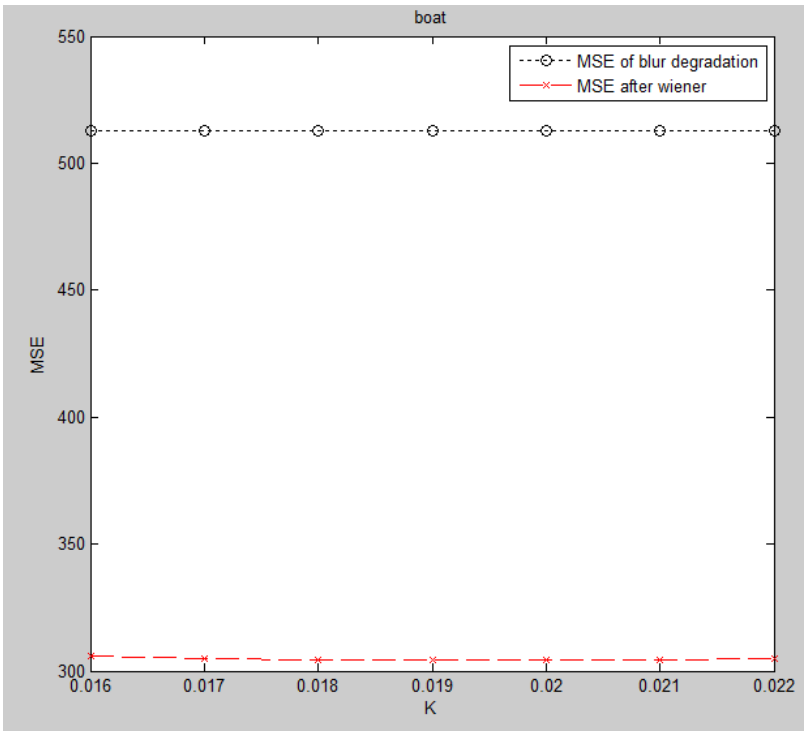
p | pT | y | tau | xbbT | all_p | fingerprint_gblur | I_01 | Io_real | H_blurdegradation | save_MSE_wiener | MSE_wiener

3x10 double

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.0000e-03	0.0040	0.0070	0.0100	0.0130	0.0160	0.0190	0.0220	0.0250	0.0280			
2	513.4379	513.4379	513.4379	513.4379	513.4379	513.4379	513.4379	513.4379	513.4379	513.4379			
3	970.9140	417.9026	345.3380	320.3315	309.5698	304.9261	303.4908	303.9759	305.7323	308.3988			

So the best K should between 0.016 and 0.022

We try K=0.016 to 0. 022 with interval of 0.001 and draw the MSE line.



p | pT | y | tau | xbbT | all_p | fingerprint_gblur | I_01 | Io_real | H_blurdegradation | save_MSE_wiener | MSE_w

3x7 double

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.0160	0.0170	0.0180	0.0190	0.0200	0.0210	0.0220						
2	513.0351	513.0351	513.0351	513.0351	513.0351	513.0351	513.0351						
3	305.8582	305.0711	304.5773	304.3314	304.2977	304.4475	304.7574						

As a result, the best K is 0.020. The MSE is 304.2977. K should not be too small or large. If K is too small, then W=1/H, if H(u,v) is too small in some area, then recovered image would be greatly influenced by noise. If K is too large, then the detail would be suppressed.

The Wiener Filtered Images with different K are shown below

K=0.1

K=0.01

K=0.001

K=0.02(min MSE)